Memorandum

To: Gary Turney, Tony Paulson, Bill Simonds, Bob Cusimano, Christine Psyk, Ben Cope, Aimee Christy, Mike Brett, Suzanne Osborne, Matthew Wiley, Lalena Amiotte, Keith Grellner, Dave Christensen, Cliff Kirchmer

From: Mindy Roberts

Cc: Jan Newton, Dan Hannafious, Mitsuhiro Kawase, Jeff Richey

Date: October 31, 2005

Subject: Response to Comments on Draft Hood Canal Quality Assurance Project Plan

Thank you for commenting on the draft document or providing inserts. Edits have been incorporated into the final document, soon to be posted to the Hood Canal web site as the official Year 1 plan. In some cases, this document could not address the comment or I did not make the change suggested. This memorandum summarizes the edits and tracks the currently unanswered questions that will be important to address for the second year of activities under the Hood Canal DO Program. These can be incorporated into the Year 2 QAPP that will be developed this winter to cover activities for the period May 2006 through April 2007 (roughly).

Please review the response to comments and let me know if anything has been misinterpreted or if delaying until the subsequent QAPP is not appropriate. Also, please review Attachment 1 for accuracy since many of the unanswered questions relate to data collection and model development by UW, USGS, and Ecology. Page numbering refers to the August 25, 2005, draft document (*hcdop_qapp_rev9-2.doc*). The original comments are not included, but if anyone would like a copy, please let me know.

Bill Simonds (USGS)
- Edits inserted with minor modifications

Tony Paulson (USGS)
- Edits inserted with minor modifications

Gary Turney (USGS)
- Annual loading units described in text
- Figure 17 modified with actual coordinates

Aimee Cristy (Pacific Shellfish Institute)
- Phytoplankton identification citations included in text and references
- Lab protocols added as appendix to document with ORHAB reference

Lalena Amiotte (Skokomish Tribe)
- Table 10—*in situ* parameters, Skokomish station, staff gage reading vs. flow measurement stations indicated, verified lab parameters

Suzanne Osborne (UW and USGS)
- Updated Table 19 (previously USGSWQ-1) with isotope methods

- Bill or Suzanne had previously sent the iron expected range of results as 6 to 5000 ug/L, but the more recent table specified 0.03 ug/L to 10 mg/L. I verified with Bill by e-mail that the expected range of results should be 6 to 5000 ug/L.

Matthew Wiley (UW)
- Included Daly and SCAS citations in references

Mark Wagner (UW)
- Refined description of particulate flux and remineralization in UW marine model section as suggested.

Bob Cusimano (Ecology)
- Reviewer #1
    - All comments relate to the terrestrial and marine model development and how they will interact. These comments should be addressed in the Year 2 QAPP and should be included in a larger discussion of model development and data collection activities in support of the second QAPP. Comments are included in Attachment 1 and will be revisited during Year 2 QAPP development.
- Reviewer #2
    - Comments on the marine data collection design should be discussed during a larger discussion of model development and data collection activities in support of the second QAPP. These comments are retained in Attachment 1 and will be revisited during Year 2 QAPP development.
    - Ecology is pursuing independent funding for the development of a Hood Canal dissolved oxygen model using currently available software. The model approach should be described in the Year 2 QAPP; no changes were made to the Year 1 QAPP.
- Reviewer #3
    - Comments 1 and 2 incorporated. Mark Hicks (Ecology) has read and approved the language regarding state water quality standards in the final document.
    - Comment 3—We tried to minimize the general information included in this document because so much material exists. Some of the parameters, like residence times of the basins, will be developed during the course of the study. Gages on the larger rivers are upstream of the mouth such that flows must be estimated. We intend to use modeling and statistical tools to do that, but the information is not available currently.
    - Comment 4 will be included in the Year 2 QAPP following a more detailed discussion. The comment is included in Attachment 1 and will be revisited during Year 2 QAPP development
- Reviewer #4
    - Marine Sampling, Comments 1 through 5 should be included during a larger discussion of model development and data collection activities in support of the second QAPP. These comments are retained in Attachment 1 and will be revisited during Year 2 QAPP development.
    - Marine Sampling, Comment 6—Year 1 activities do not include any current velocity measurements; therefore, no change was made to the Year 1 QAPP. However, the comment is retained in Attachment 1 and will be included in a larger discussion of model development and data collection activities in support of the second QAPP.

    - Marine Sampling, Comment 7—Links between the biota studies and other data collection activities will be more clear in the Year 2 QAPP, after the initial benthic data review has been completed. These comments are retained in Attachment 1 and will be revisited during Year 2 QAPP development.
    - Marine Modeling, Comments 1 through 3—The comments are retained in Attachment 1 and will be revisited during the development of the Year 2 QAPP.
- Reviewer #5
    - The suggestion for a summary table with the leading hypotheses for what is causing the low DO has been worked into a discussion of the DO conceptual model for Hood Canal.
    - Comments 2 and 3 should be included during a larger discussion of model development and data collection activities in support of the second QAPP. These comments are retained in Attachment 1 and will be revisited during Year 2 QAPP development.

Christine Psyk and Ben Cope (EPA)

- General comments
    - Development of new models—Model development, validation, and coordination will be included in a larger discussion of model development and data collection activities in support of the second QAPP. The comment is retained in Attachment 1 and will be revisited during Year 2 QAPP development. Peer review of models will be described in the subsequent Year 2 QAPP. Ecology is pursuing additional funding to model Hood Canal using currently available software that has been applied in other TMDL projects.
    - Computer processing requirements—Computer processing needs will be part of a larger discussion of model development and data collection activities in support of the second QAPP. The comment is retained in Attachment 1 and will be revisited during Year 2 QAPP development.
- Specific comments
    - Pages 3, 6, and 8—A sidebar was added to describe the conceptual model for dissolved oxygen.
    - Page 8—TMDL language was necessary to meet our internal Ecology requirements that any sampling done in support of a TMDL be covered by a QAPP. In this case, Ecology has not determined that a TMDL will be done, but we wanted to maintain that option. We state that Ecology would be developing the TMDL rather than another entity.
    - Page 8—Background discussion was maintained under the study area description, but the suggested conceptual model section has been added to the document. That text mentions Puget Sound as a nutrient source.
    - Page 10—done
    - Page 12-13—Changed the section title to Historical Study Review. We wanted to keep the nitrogen load estimates with the historical data.
    - Pages 15 and 16—The Organization and Schedule section, including Figure 4, was completely re-written to better reflect the disparate sources of funding being used by the project collaborators to bring several ongoing monitoring programs under one umbrella. In some cases, new monitoring is being conducted to fill gaps in current networks, and these efforts are funded by HCDOP. In others, local entities were already monitoring in situ parameters, but they are now collecting water quality samples to be analyzed by UW for a common set of nutrients. The overall network has developed from a series of formal and informal meetings among HCDOP participants.

- Page 21—The terrestrial model is being developed for both purposes: simulating the effects of land use on tributary quantity and quality and filling gaps in the monitoring program. The specific processes to be modeled will be the subject of ongoing discussions described in Attachment 1.
- Page 23—done
- Page 27—Cloud cover and pressure are generally estimated from the current weather station network. We will discuss whether site-specific data may be obtained during Year 2.
- Page 36—Including BOD analyses in tributaries will be discussed as part of the Year 2 planning. A limited amount of BOD data from western Washington suggests that freshwater BOD tends to be <1 mg/L.
- Page 39—The study data have been entered into Ecology's EIM database, and no ammonia data were collected. However, ammonia is currently being collected in those streams, beginning June 2005
- Page 40—TDN is defined in a footnote to the table and in the acronyms of Appendix 1.
- Page 41—Attachment 1 includes in situ parameters in streams monitored by Mason and Jefferson counties as a data gap. HCSEG and UW will attempt to provide the meters during Year 1, and the gaps will be discussed during Year 2 QAPP development.
- Page 48—Detailed weather data on Hood Canal and in its watershed have been identified as data gaps in Attachment 1. These will be discussed during Year 2 QAPP development.
- Page 49—The NPDES permit for the Alderbrook discharge does not require monitoring of nitrate or ammonia in the effluent. This is noted in the document, listed as a data gap in Attachment 1, and will be discussed in preparation for Year 2 activities.
- Page 64—Integration of data from data collectors will be discussed and documented in the Year 2 QAPP. During Year 1, data collectors will maintain data and analysts must contact those agencies to obtain electronic copies. The final Year 1 QAPP clarifies this, as suggested.

Mike Brett (UW)

- Septic system nutrient load compilation section is included in QAPP, but revised to reflect suggestions by Dave Christensen. Further refinements and potential monitoring programs should be included in a larger discussion of model development and data collection activities. The subject is included in Attachment 1.
- The approach for other anthropogenic nutrient sources, such as agricultural and residential fertilizer application rates, livestock and pet waste generation, and forest biosolids applications should be included in a larger discussion of model development and data collection activities. Reference to this was added to the UW Terrestrial Model section under Model Inputs.
- The atmospheric deposition supplemental monitoring has been included in the document as a brief summary. The full text is included as an appendix.
- A brief description of the proposed stormwater monitoring program is included in the document, and the full text is included as an appendix.

Keith Grellner (Kitsap County Health District)

- The draft septic approach has not been included in the final document, and no mention of direct discharges was included. Instead, the final document references the PACA report

and USGS efforts, as well as the efforts coordinated by the Puget Sound Action Team to characterize nitrogen removal of various onsite systems; all of these were suggested and included. UW will coordinate the efforts to refine the estimates using the best available information.

Dave Christensen (Hood Canal Coordinating Council)

- The suggestion to further quantify the septic and groundwater nitrogen loads should be included during a larger discussion of model development and data collection activities in support of the second QAPP, since this would require additional data collection activities not currently funded for Year 1. These comments are retained in Attachment 1 and will be revisited during Year 2 QAPP development.
- The previously separate septic system approach write-up has been modified and incorporated into the Experimental Design section. The text has been revised to reflect anticipated year 2 activities and the existence of other information related to refining the onsite sewage inputs.

Cliff Kirchmer (Ecology)

- The requested detailed response to comments is included as Attachment 2.
- The modeling and inter-laboratory comparisons comments are included in Attachment 1 with currently unanswered questions. These will be retained for inclusion in the Year 2 QAPP discussion.
- Data verification and validation will be conducted in subsequent years and will be described in the Year 2 QAPP to be developed. The comment will be retained for future discussion.
- Data usability assessment was included with data verification and validation; however, the comment will be expanded upon during Year 2 QAPP development and is retained in Attachment 1.

Attachment 1
Outstanding Issues, Data Gaps, and Comments

A. Outstanding Issues

- Terrestrial loading model development by UW
    - peer review plan
    - computational resources
    - method for isolating watershed anthropogenic activities; what data are needed to provide model input and compare against model output
- Terrestrial data collection program
    - is BOD needed? if so, BOD5 or uBOD?
    - additional data needed to isolate anthropogenic activities?
    - refining septic system inputs beyond the PACA report and USGS estimates
- Marine water quality model development by UW and USGS
    - peer review plan
    - computational resources
    - sediment oxygen demand
    - possibility of third model by Ecology using peer-reviewed software; may provide comparison with UnTRIM and ROMS/ABC
- Marine data collection program
    - frequency/intensity of profile data, including July-September, Admiralty Inlet, lateral variation
    - defining boundary conditions—existing stations, Admiralty Inlet conditions, possibly shift ORCA station
    - current measurements—need additional ADCP work?
    - meteorological data—sufficient spatial and temporal scale?
    - biological data for the biogeochemical model

B. Noted Data Gaps

- Alderbrook wastewater treatment plant discharge total nitrogen, nitrate, and ammonium concentrations
- In situ data for smaller tributaries monitored by Jefferson and Mason counties
- BOD (BOD5 or UBOD) in tributaries and point sources
- Detailed meteorological data throughout Hood Canal marine domain (including wind speed, cloud cover, air pressure, etc.)
- Detailed precipitation data throughout terrestrial domain
- Lateral variation in marine water column profiles
- Phytoplankton data (Ecology, Reviewer 4)
- Data to develop boundary conditions for various climate scenarios

C. Comments to be addressed during subsequent project plans (not incorporated into the Year 1 QAPP)

Ecology Reviewer #1:

Marine Biogeochemical Model Development

Both the USGS and UW marine efforts are applying models that have not been used for water quality regulatory purposes. Because of that, algorithm testing results and model verification information should be provided (i.e., cite published literature or reports that discuss model performance for both water quality and hydrodynamic models). If new models are being developed/applied (e.g., ABC marine geochemical model and the DHSVM terrestrial geochemical model) then both algorithm testing and verification that the theory adequately describes the underlying systems and that the code reproduces the theory should be done. Also, some kind of official peer review should be conducted, depending on things like the Credible Data provisions. If this work has already been done it should be noted in the QAPP. In addition, there may be some value in applying an existing, peer-reviewed model to Hood Canal to provide some quick results and to provide a basis on which to compare the other models.

The effects of human activities will need to be assessed using the marine model, so the models should be developed with this in mind (probably more relevant to the terrestrial model, which includes human activities). Related to this will be the need to model natural conditions within Hood Canal, and determining what data are needed to describe natural conditions (e.g., ocean boundary conditions, river flow, etc.).

There needs to be more discussion regarding how the two marine models will work together and how they will be integrated with the terrestrial model(s).

Terrestrial Model Development

It is my understanding that UW will be adding on biogeochemical processes to an existing distributed hydrology model (DHSVM) (?). Same concerns as for marine models noted above whenever you create a new model. I am not sure that we have sufficiently detailed spatial data to drive the model, particularly in terms of how the groundwater will be represented. Also, DHSVM is a very complex model without a graphical user interface [that I know of (?)]. I'm not sure anyone but UW Civil Engineering students will be able to run the model. Plus, adding on a complex system like nitrogen generation and transformation is no easy task. This could take years and go beyond the 3-year project time frame to produce a working model.

In the meantime, I believe there would be value in preparing loading functions that utilize the discrete monitoring data being collected under the program and in ongoing county and state programs. These loading functions could be used in the interim to drive the marine models until the terrestrial modeling is completed.

The terrestrial model should be developed with specific human activities/nutrient sources in mind so that the model can be used to compare various management strategies (e.g., remove all septic systems, require agricultural BMPs, return to conifer forests, etc.). These must be built into any model that is used to develop load allocations. Related to this is the need to consider how to define natural conditions in both the terrestrial and marine systems. The models must be capable of simulating natural conditions, and data need to be developed that describe

natural conditions. This is a very difficult scenario to quantify, but it's a necessary step in Ecology's ability to use the program results to set load allocations and determine load reductions (i.e., for a TMDL).

Links between the terrestrial and marine modeling are not included in the QAPP, and are not discussed in general. The most pressing question is whether the terrestrial modeling effort will produce output at an appropriate temporal and spatial scale for the marine models and will provide the appropriate nitrogen compartments.

Marine Data Collection Activities

Are the correct nitrogen compartments being collected from the marine system to parameterize the marine models? In other words, are the nitrogen species that the models use measured in the data collection program? Are there any short-term or intensive data collection programs necessary to calibrate key biogeochemical processes in the marine models? What rate constants are the models most sensitive to, and are there data collection programs necessary to develop these?

Terrestrial Data Collection Activities

Are there additional data collection needs to support determination of natural conditions?

Are the correct nitrogen compartments being collected from the freshwater systems to parameterize the terrestrial and marine models? In other words, are the nitrogen species that the models use measured in the data collection program?

Are additional data necessary to characterize the groundwater component being developed for the terrestrial modeling?

Ecology Reviewer #2:

Sampling

My main comment is that I think there should be more frequent intensive sampling of the water column of Hood Canal for at least one year (more than one year would be better). I would very much like to see the PRISM and HCSEG monitoring supplemented such that there would be monthly monitoring at all of the 11 PRISM stations shown in Figure 6, plus one station in Admiralty Inlet, for at least one year. During the July-September period it would be even better if the sampling was every 2 weeks for a total of around 15 cruises in a year.

The purpose of this supplemental intensive sampling of profiles along Hood Canal would be to develop a more detailed database for model calibration of profiles of temperature, salinity, density, dissolved oxygen, nutrients, and phytoplankton. I would like to see the same sampling regimen that is described for each of the UW PRISM cruises applied for 15 cruises in one year instead of only two. In situ parameters would be recorded using a Sea-Bird CTD. Discrete samples are collected at depths of 0 m, 5, 10, 20, 30, 50, 80, 110, 140 m, and near-bottom, based on the station depth. Samples would be analyzed for chlorophyll a and phaeopigments, nitrate, nitrite, ammonium, orthophosphate, and silicate. Discrete samples would be collected at two stations for primary productivity studies during each cruise.

It is most critical to include the Admiralty Inlet station in addition to the 11 Hood Canal stations during the proposed frequent intensive monitoring. In general I think there is not enough monitoring of the boundary condition in Admiralty Inlet. The success of the model calibration is dependent on the quantity and quality of data from the boundary condition in Admiralty Inlet. The Admiralty Inlet data will be extremely important to establish the boundary condition for input to any numerical model.

I would also like to see one of the ORCA mooring placed in Admiralty Inlet instead of having all of them in Hood Canal. I am concerned that the proposed location for the northern Hood Canal ORCA mooring will not be useful as a boundary condition because it is influenced too much by processes within Hood Canal.

Modeling

The Department of Ecology would like to add a third modeling component using an existing modeling framework to complement the suite of models that are currently underway by UW and USGS. Ecology has initiated application of the GEMSS modeling framework to Hood Canal (see attached Powerpoint file [Attachment 3]). The GEMSS framework was developed by J.E.Edinger Associates, Inc. (www.jeeai.com) and has been successfully applied in Budd Inlet for the LOTT study. GEMSS meets Ecology's typical preference for using existing generalized modeling frameworks that have been extensively tested. CPU requirements are also a central criterion for our model selection, and we generally prefer models that can be run on a standard desktop PC. Ecology
has also considered the application of the EFDC framework for Hood Canal. Ecology has previously applied EFDC to southern Puget Sound.

Progress on the Hood Canal GEMSS application so far includes development of a computational grid and bathymetry with calibration to tides (see attached Powerpoint file). Preliminary comparisons of predicted and observed density profiles have also been conducted.

Ecology Reviewer #3:

The QAPP should include a section on modeling quality control, including modeling data quality procedures, how data inputs for the modeling will meet the requirements of the Credible Data law (RCW 90.48.580 & .585), data quality objectives for modeling, and modeling validation and verification.

Ecology Reviewer #4:

Marine Sampling

1. More frequent sampling is required to ensure that important dynamics are captured, particularly the upwelling/downwelling that appears to be associated with the die offs.
2. The PRISM stations are located down the central axis of the Canal and so do not provide information on the cross-canal distribution of oceanographic properties. Although the volunteer program does sample the edges and will have some profiles, I think that it's important to have frequent transects, with larger numbers of water column profiles, across the Canal at 3-4 selected locations to ensure that the cross-shelf distribution of oceanographic properties is adequately captured. This is necessary to understand flows within the Canal and to verify the models' abilities to reproduce those flows in shallow areas, where some of the most visible biological impacts occur.

3. More frequent sampling is also required around the Great Bend and into Lynch Cove. The PRISM stations do not extend into this area, which suffers from the worse DO problems.
4. It is important to ensure that all samples, but particularly those in shallow areas include measurements taken as near to the bottom as feasible in order to characterize the sharp gradients in DO that may occur there.
5. I also agree that placement of an ORCA that would provide boundary condition information is important and should be done as soon as possible, perhaps even if that means moving one of those already installed. The present monthly samples (potentially less in winter if relying on the Ecology flight program) do not adequately capture this variability. I think that understanding short and long-term variability in the boundary condition is probably more important to the modeling effort that the additional profile information gained by locating both ORCAs down the Canal.
6. There is also little reference to current measurements, except the limited deployment by the USGS. I understand that further sampling has been discussed, but that no plan has yet emerged. However, I think that it's important that the QAPP include a section on the rationale for a proposed design if the work is to begin during this first year.
7. A clear strategy for integrating the biota studies with the overall modeling and corrective action plan is lacking. In this QAPP, the biological studies come across as an afterthought, with little apparent connection to the larger project.

Marine Modeling

I concur with other's comments on the need for an alternative, peer-reviewed modeling effort. It's not clear if, how, or when the models being developed would be suitable for use in a regulatory framework.

1. Given the complicated nature of the biogeochemical model(s) that will be used, I 'm concerned that there is no discussion about the kinds of biological data needed to adequately parameterize the models, whether those data are available, and if not, what the plans are for obtaining reasonable estimates. For example:
    a. Are the benthic flux data cited in the QAPP sufficient?
    b. How will the lack of plankton data be addressed?
2. A more detailed description of the model parameters and how they will be estimated – including the expected range of variation in those estimates – should be included.
3. A process and timeline for verifying and ensuring peer-review of the proposed models should be included.

Ecology Reviewer #5:

(*Following discussion of need for conceptual model identifying hypotheses to be tested*.) And connected to this, perhaps in this same table, a list of what data or model runs will be used or collected to test each hypothesis. For example, to see whether dry conditions could account for years were Hood Canal does not physically flush identify a year where HC flushed and one where it did not. Do you already have the data to test the flushing with model runs, or do you need to collect more. If so, what would be the QA requirements for these new data (how often for how long -- usually fall into winter is the critical time for flushing).

I think the timing of physical flushing and the nitrogen loading (USGS table) will be keys to the understanding of the low DO observations. The timing of events is something the model can handle very well. Maybe the lowest DO happens on years after there has been plenty of

northerly winds leading to upwelling (providing nitrate to the surface waters) followed by a late summer drought bumping the water densities up in HC and sealing it off from outside waters. Going out and sampling for the next year may not necessarily provide the data we need (unless we get lucky).

Dave Christensen:

The methodology to estimate onsite sewage inputs of nitrogen to Hood Canal appears open to similar criticisms that we received, in drafting the Preliminary Assessment and Corrective Actions Plan (PSAT and HCCC, 2004). It appears to improve the estimates slightly, by separating out nearshore, shallow groundwater discharge vs. more distant onsite systems that would recharge groundwater and then discharge to Hood Canal through more regional groundwater flow paths. However, for the size and scale of the project being undertaken, it seems that there should be an attempt to use more up-to-date information. The PACA was an admitted "very rough cut estimate" for nitrogen loading from human sources.

For instance, from the La Pine National Onsite Demonstration Project (located near Bend, Oregon), USGS researchers are finding that significant denitrification is occurring in the anoxic portion of the aquifer. In their study, nitrogen from onsite sewage systems is being mapped as it is transmitted down from the surface of the aquifer that is oxygenated, over time traveling into the deeper part of the aquifer that is anoxic. They are measuring significant denitrification, which would reduce the overall nitrogen loading from regional aquifers into surface waters where the aquifers are discharged.

Another example of updated information is the monitoring information that will be collected by projects being funded by the Puget Sound Action Team. In those projects, local health departments are measuring nitrogen concentrations leaving a number of different types of onsite sewage systems. Because this data is not available at this time, the QAPP could acknowledge that this data will become available and you intend to use it in your model.

Christine Psyk:

General Comments

The water quality components of the two HCDOP models appear to be in the software development stage at present. EPA and Ecology generally use established model software for TMDL development. Examples of more commonly used model software include CE-QUAL-W2, QUAL2E, and EFDC-WASP. These programs have been documented, peer-reviewed, and widely tested in a variety of environments. While we are always open to the use of new programs that advance the science, we believe that it is most efficient to use existing modeling programs when possible. If an improved formulation for a particular process is needed in the existing model framework, one can make minor code enhancements to the framework and peer review only the change in the software, thus saving time and resources.

Regarding computer resources, the agencies are currently organized to conduct our assessments using standard PC workstations. Therefore, processing requirements and model run times are a central criterion for our model selection, and we generally do not select models that cannot be run on a standard PC. It is our understanding that the proposed model frameworks for HCDOP may require higher performance computing systems that are not available to Ecology.

Ecology's Environmental Assessment Program has a capable cadre of engineers and scientists that develop and apply water quality models across the state, and EPA believes HCDOP should take full advantage of the state's analytical resources. We are concerned that the issues with HCDOP's modeling plan may necessitate a separate effort by Ecology to develop a model for its TMDL work. With two models currently under development, we note that the document advocates an "ensemble" of models of Hood Canal. Rather than re-consider the selection of the two model systems under development by HCDOP, EPA would support an effort by Ecology to develop a third model in the ensemble using currently available software. Using the data collected to date, we believe a useful water quality model can be developed in a matter of months once resources are directed to the task. If we can accelerate the model development timeline, it would allow us to estimate the sensitivity of dissolved oxygen levels to various boundary conditions and adjust future monitoring toward areas of greatest importance.

Specific Comments

Page 21—We suggest more clarity on the purpose of various models. We can envision two specific purposes of the terrestrial model. 1) to estimate the effects of land use changes on tributary water quality, and 2) to fill gaps in the tributary monitoring record to improve the estuary model development.

Page 27—Note that water temperature models require estimates of pressure and cloud cover in addition to parameters discussed in first paragraph.

Page 36—General comment on water quality monitoring: While most plans include complete nutrient analyses, biochemical oxygen demand (BOD) is not included. This will require modelers to assume concentrations for BOD at model boundaries and advective inputs to the canal. Has this data gap been considered by HCDOP and others?

Page 41—Tables 11 and 12. No in-situ monitoring. This should be identified as a data gap.

Page 48—Add section on Weather Data. Should include National Weather Service locations (and parameters) and other local sources of data like marine buoys.

There are a number of gaps and inconsistencies in the ongoing monitoring. We recommend adding a chapter on this issue and include recommendations to resolve each gap/inconsistency. For example, if one entity collects chlorophyll-a samples at the surface and 10 meters depth and another entity collects chlorophyll-a samples at 5 and 10 meters, HCDOP could recommend that future sampling occur at consistent, specified depths.

Page 64— This discussion does not answer the fundamental question of a typical data user: How can one gain access to the electronic data generated under this project? The cited nodes offer graphical data presentations but not download capability for electronic data. Does HCDOP envision data download from these sites in the future? Is there a project plan to get from here to there under development? In the meantime, the document should probably state the obvious for Year 1: the data is currently distributed among the organizations collecting it, and analysts must contact data owners to obtain electronic data.

Also, it is unclear how data collected by Dept. of Ecology, USGS, and National Weather Service are included in these nodes. Ecology and USGS sites support downloading of data. National Weather Service requires a subscription.

Cliff Kirchmer:

I do not have any comments on the Modeling Approach and Experimental Design Sections, other than to state that it is important to remember that in order for these models and experimental designs to provide the information necessary for decision making it is essential that accurate data are input to the model and design. There may be some information of use regarding models in the EPA Guidance for Quality Assurance Project Plans for Modeling, http://www.epa.gov/quality/qs-docs/g5m-final.pdf. This document provides information about how to document QA planning for modeling.

…[T]here is a need in this program for an interlaboratory analytical quality control program for laboratories analyzing waters of Puget Sound and an intercalibration program for both field analyses. However, this will likely have to be a long-term objective.

…

There is also a need to provide more information on assessment. A section on Data Quality (Usability) Assessment (DQA) should be added. As explained in the guidelines, this section should explain how you will assess the usability of the data and what graphical and statistical tools you will use to determine if the project objectives have been met. The EPA QA/G-9 document is a good reference source for the scientific and statistical analysis of data http://www.epa.gov/quality/qs-docs/g9-final.pdf.

Verification and validation of data is also part of assessment. Data should be verified and validated before being assessed for usability or reconciliation with user requirements. While a section on Data Verification and Validation is included in the QAPP, more information should be included regarding the procedures to be used. Data verification is done by those who made the measurements, whether in the field or the laboratory. After the data are verified, they should be validated, to determine if the measurement quality objectives (MQOs) have been met. The data validation report should be prepared by someone who was not involved in doing the measurements. The QAPP should require that data verification and data validation reports be prepared for all of the data that is collected. The laboratory's case narrative often includes all of the information required in a data verification report. Data entered into Ecology's EIM database now must indicate whether data verification and data validation reports have been prepared. This is necessary to meet the highest level of data quality, which is one of our GMAP Performance Measures for FY05-07.

…

In Table 5, can you specify activities for "data verification and data validation" and "data quality (usability) assessment"? It may be that these activities are too widely dispersed to assign responsibility, but if possible add these activities to the table.

Attachment 2
Response to Comments of Cliff Kirchmer, Ecology Quality Assurance Officer

DEPARTMENT OF ECOLOGY
ENVIRONMENTAL ASSESSMENT PROGRAM

M E M O R A N D U M

September 20, 2005

TO: Mindy Roberts

FROM: Cliff Kirchmer

SUBJECT: Review of QAPP for "Hood Canal Dissolved Oxygen Program Integrated Assessment and Modeling Study Year 1 Activities"

Responses to comments shown in italics (Mindy Roberts, October 31, 2005)

This is a complex project, involving the cooperation and coordination of many individuals and institutions to achieve the project objectives. The QA Project Plan covers all of the recommended elements, except for Data Quality (Usability) Assessment, and the background and information on the procedures used by the multiple participating agencies have been thoroughly researched. The document is impressive in its scope and content. However, one could argue that this could have been split into several QAPPs, in order to make certain that each of the activities is implemented correctly and that all of the necessary data is collected.

Because the activities are so dispersed among and within agencies and the ongoing monitoring programs are already covered by individual QAPPs, one document was developed as a single point of reference for all participants. Where applicable, this QAPP refers to specific QAPPs for further information. However, some of the programs are new and not covered under other QAPPs.

Data Quality (Usability) Assessment was added to the Data Verification and Validation section to more specifically address the requirements in the guidelines instead of working the elements into other sections of the QAPP. However, this comment will be addressed more completely during discussions necessary to develop the Year 2 QAPP. The comment will be retained.

The primary element/section that may need to be edited is the "Measurement Quality Objectives" for Laboratory Measurements. Table 16 was apparently prepared using the February 2001 Guidelines for Preparing QAPPs, rather than the current July 2004 Guidelines. The current guidelines recommend specifying the MQOs in the same units as used for specifying QC limits (i.e. Appendix H-1). This change in the guidelines was done after receiving comments that project leads and the laboratory had difficulty judging whether the MQOs were met when based on the targets for accuracy (precision and bias).

The document was prepared in accordance with the July 2004 guidelines, included with the references. In some cases the section titles were different than suggested in the guidelines. Table 16 attempted to specify the necessary information using other terms than those recommended in Appendix H to the guidelines. Future QAPPs will include the wording suggested from the guidelines. I would like to leave the current terminology in place.

The MQOs for Field Measurements in Table 16 are probably OK. You might want to clarify how you will verify that these MQOs have been met. Operational verification can be done in part by specifying the maximum deviations allowed for calibration checks. In general, the accuracy of field measurements depends on strictly following the standard operating procedures, with particular emphasis on the procedures and frequency of calibration. When possible, discrete samples should be taken to check the instrumental readings by an independent chemical analysis (e.g. Winkler for dissolved oxygen).

If Table 16 is kept as is, there should be some additional explanation regarding how the information obtained from the QC samples analyses will determine whether the MQOs have been met. One way to do this would be to specify in the Section on Quality Control the QC limits that you think are necessary to meet the MQOs in Table 16.

The Quality Control section reflects how to determine whether the MQOs specified in Table 16, which are in percent variation for laboratory measurements but native units for in situ values.

As is, there are a few corrections needed to Table 16. For Chlorophyll Fluorescence, Light transmissivity, and Marine Nitrate, Accuracy should be 25%, not 10%.

Changed for chlorophyll and light but kept 10% for marine nitrate because the University of Washington Marine Chemistry Laboratory will analyze the samples and uses 10%.

If you decide to change Table 16 to specify MQOs in the same terms as the lab uses to specify QC limits, Karol Erickson can provide you with the spreadsheets that Manchester Lab prepared for that purpose.

There is also one relatively minor change in the 2004 QAPP Guidelines. Instead of "Required Reporting Limit", it now says "Lowest concentration (or value) of interest". The idea is that the project lead states what is the lowest concentration of interest for the project, and then the laboratory states whether their reporting limit meets that requirement.

Change made.

There is also a need to provide more information on assessment. A section on Data Quality (Usability) Assessment (DQA) should be added. As explained in the guidelines, this section should explain how you will assess the usability of the data and what graphical and statistical tools you will use to determine if the project objectives have been met. The EPA QA/G-9 document is a good reference source for the scientific and statistical analysis of data http://www.epa.gov/quality/qs-docs/g9-final.pdf

Data Verification and Validation were expanded to include the Data Usability Assessment. However, this comment will be retained for discussion and expanded on in the Year 2 QAPP developed this winter.

Verification and validation of data is also part of assessment. Data should be verified and validated before being assessed for usability or reconciliation with user requirements. While a section on Data Verification and Validation is included in the QAPP, more information should be included regarding the procedures to be used. Data verification is done by those who made the measurements, whether in the field or the laboratory. After the data are verified, they should be validated, to determine if the measurement quality objectives (MQOs) have been met. The data validation report should be prepared by someone who was not involved in doing the measurements. The QAPP should require that data verification and data validation reports be prepared for all of the data that is collected. The laboratory's case narrative often includes all of the information required in a data verification report. Data entered into Ecology's EIM database now must indicate whether data verification and data validation reports have been prepared. This is necessary to meet the highest level of data quality, which is one of our GMAP Performance Measures for FY05-07.

Data will be verified and validated in subsequent project years. Procedures will be documented in the QAPP for Year 2 activities. This comment will be retained for future discussion and documentation.

In addition to the above, I have a few additional comments.

There are many individuals/organizations contributing to the project, but only 4 individuals are identified for signing approval of the QAPP. How are you confirming that each of the individuals/organizations are in agreement with the plan, particularly the details concerning their participation and contributions to the plan?

Jan Newton and Dan Hannafious will be responsible for overall project management, including the details described for the various entities. This is stated clearly in the revised section on Organization, Funding, and Schedule.

Page 19 states that 5 persons from Ecology will review and approve the QAPP, but I am the only one listed under the Approvals on page 2.

All names will remain in the table, but the text is changed to reflect that they have reviewed the QAPP. After internal and external discussions, it was agreed that the four signatures on the QAPP title page are sufficient. The intention is to identify the QAPP as a Hood Canal Dissolved Oxygen Program document rather than primarily a Department of Ecology document.

While the title of the QAPP indicates that the project is focused on dissolved oxygen, the details of the plan include many other parameters and measurement procedures, and the focus on dissolved oxygen is lost somewhat. Similarly, mention is made that anthropogenic sources of nitrogen has been posited as a factor causing low concentrations

of oxygen, but the data collection does not seem to put special emphasis on confirming this explanation.

A new section on the conceptual model has been added to provide context. Since marine dissolved oxygen levels are driven primarily by hydrodynamics and by nutrient inputs to the system, these processes are the focus of the proposed monitoring activities. The ongoing data collection programs of Ecology and others have been characterizing in situ *dissolved oxygen levels, which will provide model calibration data. The bulk of the activities relate to model input data collection.*

In the Measurement Quality Objectives, Measurement Procedures, and Quality Control it would be good to emphasize the importance of the oxygen measurements and perhaps the measurements of the forms of nitrogen.

The new conceptual model section should support why all the parameters in Table 16 are important. DO and nitrogen analyses are included in the tables of each section, although these tables tend to be organized by in situ and laboratory measurements.

The goal and project objectives are included both in the section on Project Objectives and the section on Project Description. The information in those two sections could be consolidated, or at least edited to avoid repetition. Only one goal is given on page 15, but several goals appear to be included in the first paragraph of project objectives on page 7. The bulleted objectives on page 7 seem vague, using the verbs "continue", "supplement"
and "begin", instead of more definitive objectives. The goals and objectives should be stated as definitively as possible, so that one can evaluate later whether they have been met.

The congressional funding mechanism for the Hood Canal Dissolved Oxygen Program is year by year. However, the overall project is envisioned as a three- year effort. The project objectives section on page 7 includes both the goal of the overall, three-year project (to quantify natural and anthropogenic factors that contribute to low marine dissolved oxygen levels) and specific tasks (revised from previous wording) to be completed during the first year. This QAPP only covers the first year of activities, hence the use of words like "begin" and "continue." We will develop an additional QAPP to cover the second-year activities.

The first paragraph under Project Description summarizes the goals and specific tasks previously listed in the Project Objectives section, then expands on the task description to set up the Organization, Funding, and Schedule section that follows. The purpose is to link the large number of participants to the three-year project through their ongoing programs.

At the end of the second paragraph under Background, Description of Study Area, I am not sure if the sentence "Stratification reduces vertical mixing" is meaningful. It seems to me that a lack of vertical mixing is synonymous with stratification.

The two are related but not synonymous. From Skip Albertson:

"The greater potential energy represented by a stratified fluid requires more kinetic energy (i.e., vertical mixing) to overturn. Conversely, a given amount of vertical mixing (i.e., kinetic energy) will be more inhibited by greater stratification. When Cliff states that a lack of vertical mixing is synonymous with stratification, the subtle danger is that one appears to predict the other, but they are two separate things! You could maintain exactly the same stratification (density difference from surface to bottom) in the presence of either no vertical mixing with low river/stream flow into the estuary, or with lots of vertical mixing simply by increasing the rate of freshwater input. The ratio of these two quantities is known as the Richardson number and would be a leading candidate for an environmental index if it were as easy to measure vertical shear/mixing (with an ADCP) as it is stratification (with a CTD). Remember, just because water is stratified it _does not mean_ that there is no vertical mixing."

On pages 12 and 13 are the nitrogen load estimates and the quantified nitrogen sources all in terms of elemental nitrogen (i.e., equivalent tons of nitrogen). Recommend you clarify that the tons correspond to tons of nitrogen (or whatever it is).

The annual loads are dissolved inorganic nitrogen as nitrogen; text changed.

On page 13, I recommend you insert the acronym DIN immediately after the expression "dissolved inorganic nitrogen," so the meaning of the acronym is clear when it is used later.

Change made.

I have never seen the symbol NO23N, which is used at the bottom of page 13. It apparently means NO_2-N + NO_3-N. Maybe I am not aware of the use of this symbol and, if used, there should be a definition of its meaning in the text.

NO23N has been used in previous reports and is defined where used in the present document, including the list of acronyms.

In the last two paragraphs on page 14, the expression "Ecology certified" is used. Ecology accredits laboratories, and does not certify them. Recommend you change the text here and in other places in the document where it appears from "certified" to "accredited."

Change made.

In Tables 4 and 5, some of the affiliation information for a few of the persons listed is incomplete (e.g. Mike O'Neal – UW – which Department?)

Changes made.

Recommend that the heading of Table 5 be changed to "summarizes the project schedule" (i.e., delete "expected").

Change made.

In Table 5, can you specify activities for "data verification and data validation" and "data quality (usability) assessment"? It may be that these activities are too widely dispersed to assign responsibility, but if possible add these activities to the table.

Responsibility for data verification, validation, and usability assessment will be distributed. Each of the organizations collecting or compiling the information will be responsible for data verification and validation during Year 1. Overall project data verification and validation will be described in subsequent publications. The data usability assessment methods and responsibilities also will be described in the Year 2 QAPP. The comment will be retained.

I do not have any comments on the Modeling Approach and Experimental Design Sections, other than to state that it is important to remember that in order for these models and experimental designs to provide the information necessary for decision making it is essential that accurate data are input to the model and design. There may be some information of use regarding models in the EPA Guidance for Quality Assurance Project Plans for Modeling, http://www.epa.gov/quality/qs-docs/g5m-final.pdf. This document provides information about how to document QA planning for modeling.

Many of the comments specific to modeling have not been and cannot be answered in the present document. We anticipate that the Year 2 QAPP, to be developed this winter, will provide the additional necessary detail on the role of modeling and model development in particular. This comment will be retained for inclusion in the Year 2 QAPP.

In Table 18, the methods in the lab's scope of accreditation from Ecology do not correspond to the UNESCO or Valderrama methods that are listed.

Stew Lombard of Ecology's Lab Accreditation Unit verified that while MCL is accredited for the dissolved nutrient analyses, the lab has not received accreditation for total nitrogen or total phosphorus. A footnote was added to Table 18 to indicate this. I have passed the laboratory accreditation information to Jan Newton and Kathy Krogslund so that they can initiate the accreditation process. However, the samples will be analyzed using the Valderrama method for Year 1 activities.

At the bottom of page 57, it states that "All sampling will be done in accordance with standard USGS sampling protocols and will include quality control samples (blanks and duplicates) as per USGS guidelines." Is this only the QC for sampling? If so, what are the QC samples used for laboratory analysis? If these are the laboratory QC samples, then check samples and spiked samples should also be specified.

The USGS National Water Quality Laboratory does follow laboratory quality control protocols, including spikes and blanks. Text has been modified and a reference added.

On page 59, recommend that the sentence "Sea-Bird CTDs are used to determine vertical profiles of temperature, dissolved oxygen, etc." be changed to "Sea-Bird CTDs are used to determine vertical profiles for some of the measured parameters (e.g. temperature, dissolved oxygen)."

Change made.

Under Ecology Stream Water Quality Monitoring, I think the standard protocols used at present are those authored by Ward et. al. in 2001 (Publication No. 01-03-036), and not the 1993 WAS protocols.

Change made. WAS (1993) removed from reference list.

On page 61, under USGS Groundwater Monitoring, there is a typo or something missing in the sentence "*In situ* measurements will be used to determine is sufficient purging…." Should this be "if sufficient purging…In the second paragraph under "Quality Control" on page 61, I recommend that the first sentence be changed to: "Collecting and analyzing replicate samples…."

Typographical error corrected to "if" and second text change made.

In Table 22, page 62, for lab duplicate and matrix spikes, recommend you indicate that one will be done for each batch, even if the batch is fewer than 10 (lab duplicate) or 20 (matrix spikes).

Change made.

For the Marine Monitoring Programs, will any discrete samples be analyzed periodically to check the accuracy of the "UW Oceanic Remote Chemical Analyzer (ORCA) Buoys" or the UW Applied Physics Laboratory Moored Profiler?"

The Sampling Procedures section includes the collection of discrete samples to calibrate the sensor readings. This information is now repeated in the Quality Control section.

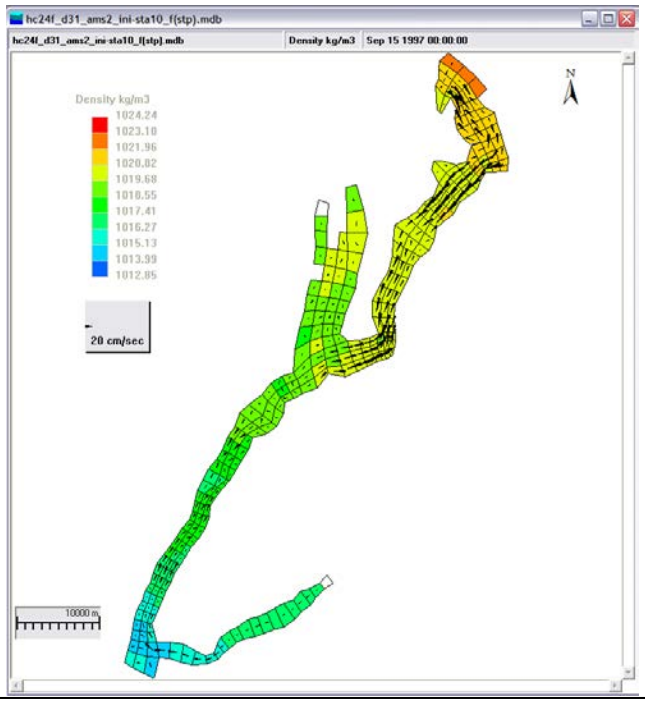
Finally, there is a need in this program for an interlaboratory analytical quality control program for laboratories analyzing waters of Puget Sound and an intercalibration program for both field analyses. However, this will likely have to be a long-term objective.

This comment will be retained in Attachment 1 and discussed as part of subsequent QAPP development.

Attachment 3
GEMSS Model Computational Grid

Hood Canal GEMSS model

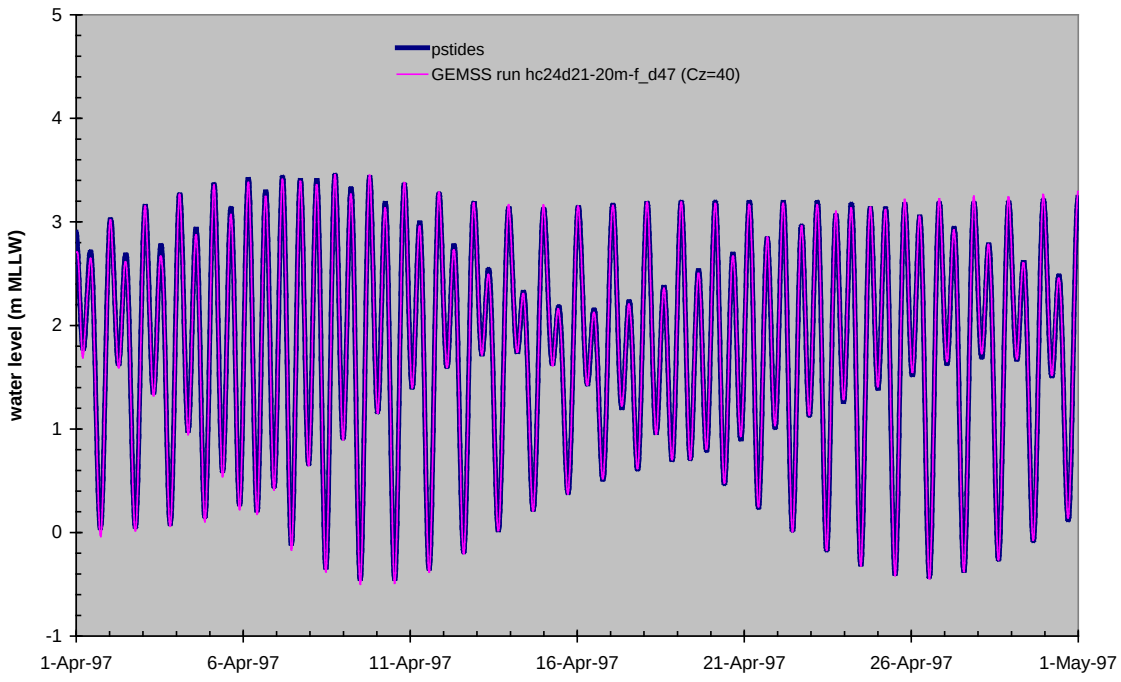
(Generalized Environmental Modeling System for Surfacewaters, www.jeeai.com)



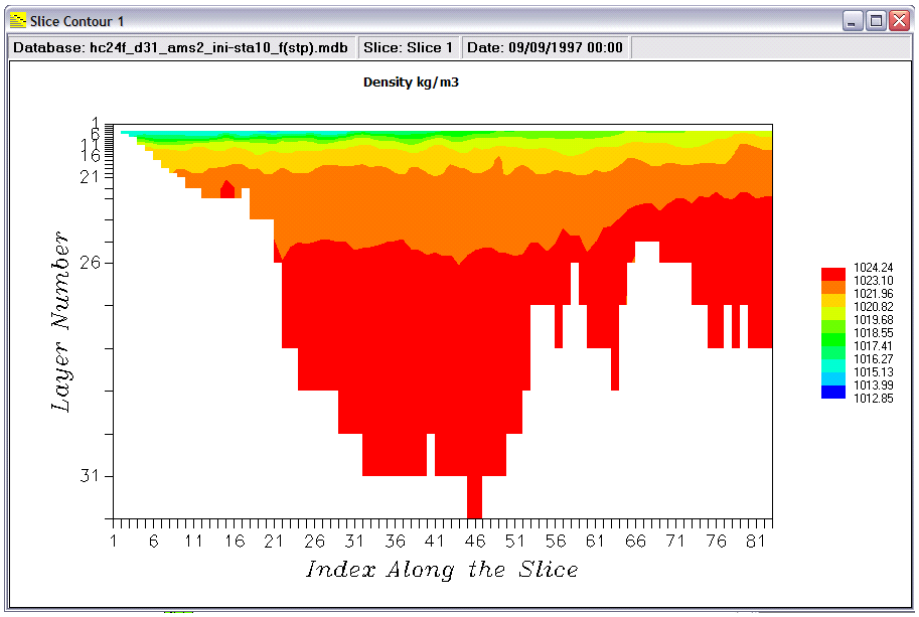
31 layers:
- 1m from surface to 10m
- 2m from 10m – 20m
- 5m from 20m to 30m
- 10m from 30m to 60m
- 20m from 60m - bottom

30-day integration takes about 5 hours on Dell D800 laptop (2.0 GHz Pentium M) with time step of 30-120 seconds.

Semi-implicit finite difference integration with Mellor-Yamada turbulence closure, QUICKEST-Ultimate transport scheme, and layer addition/ subtraction with tides.



Hood Canal GEMSS model
Density of thalweg slice, September 9, 1997



Lynch Cove

Foulweather Bluff

Figure x. Observed and predicted density profiles at UW PRISM station 10 on 9-Sep-1997 (Hood Canal near Hamma Hamma River).